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Charleston Bump Expedition
Easy as Pi

Focus
Structural complexity in benthic habitats

Grade Level
5-6 (Life Science/Mathematics)

Focus Question
How do living and non-living structures affect benthic habitats?

Learning Objectives
Students will be able to describe the importance of structural features that increase surface area in benthic habitats.

Students will be able to quantify the relative impact of various structural modifications on surface area in model habitats.

Students will be able to give examples of organisms that increase the structural complexity of their communities.

Materials
- ❒ Modelling clay
- ❒ Marbles, golf balls, or other spherical objects
- ❒ Wooden dowels, matchsticks, or similar objects; diameter approximately 6 mm or less

Audio/Visual Materials
- ❒ Chalkboard, marker board, or overhead projector with transparencies for brainstorming sessions.

Teaching Time
One or two 45-minute class periods, plus time for group research

Seating Arrangement
Groups of 4-6 students

Maximum Number of Students
30

Key Words
Charleston Bump
Habitat
Deep-water coral
Sponge
Structural complexity

Background Information
The Blake Ridge is a large sediment deposit located approximately 400 km east of Charleston, South Carolina on the continental slope and rise of the United States. The crest of the ridge extends in a direction that is roughly perpendicular to the continental rise for more than 500 km to the southwest from water depths of 2,000 to 4,800 m. About 130 km east of the Georgia-South Carolina coast, a series of rocky scarps, mounds, overhangs, and flat pavements rise from the surface of the Blake Plateau to within 400 m of the sea surface. This hard-bottom feature is known as the Charleston Bump. While the Blake Ridge has been extensively studied over the past 30 years because of the large deposits of methane hydrate found in the area, benthic communities on the continental shelf of the United States are virtually unexplored (visit http:

//198.99.247.24/scng/hydrate/about-hydrates/about_hydrates.htm for more information about methane hydrates and why they are important). Although this area has been important to commercial fishing for many years, until recently it was generally assumed that benthic communities of the continental shelf were scattered and relatively unproductive,and that useful fisheries were the result of migrations from other areas and/or nutrients carried in from deeper or coastal waters. But once scientists actually began exploring the area more thoroughly, they found many diverse and thriving benthic communities.

As the Gulf Stream flows around and over the Charleston Bump it is deflected, producing eddies, gyres, and upwellings downstream (to the north). These kinds of water circulation patterns are associated with increased concentrations of nutrients and marine organisms in many other areas of the Earth's oceans, and may be an important factor to the productivity of the southern U.S. continental shelf.

The 2001 Islands in the Stream Expedition to the Charleston Bump found a series of very complex habitats, and numerous fishes and invertebrate species involved in communities that we are just beginning to understand. (Visit http://oceanexplorer.noaa.gov/explorations/islands01/log/sab_summary/sab_summary.html, and click on logs from September 27, 28, and 29 for more information). One of the most conspicuous features of biological habitats on the Charleston Bump is spatial variety. Rock formations include flat pavements, boulders, caves and overhangs. On top of this foundation, branching corals, sponges, and other animals add to the variety, creating countless "microhabitats" in many sizes. In this activity, student will create models that illustrate this spatial variety, and will calculate the effect of various structures on total surface area in their model habitats.

Learning Procedure

1. Review the concept of habitats. Have students brainstorm what functions or benefits an organism receives from its habitat. The students, list should include food, shelter (protection), and appropriate nursery areas. Lead an introductory discussion of the Charleston Bump and the 2001 and 2003 Ocean Exploration expeditions to the area. The website for the 2001 Islands in the Stream expedition is: http://oceanexplorer.noaa.gov/explorations/islands01/log/sab_summary/sab_summary.html; click on logs from September 27, 28, and 29. The website for the 2003 Charleston Bump expedition is: http://oceanexplorer.noaa.gov/explorations/explorations.html; click on "Charleston Bump." You may want to show students some images from the Ocean Explorer website and/or http://pubs.usgs.gov/of/of01-154/index.htm.

   Tell students that detailed surveys of the Charleston Bump are just beginning, but we can have a general idea of what to expect based on explorations in other deep-water, hard-bottom habitats. Explain the concept of "microhabitat." Be sure students understand how the combination of various rock formations and organisms with complex physical forms (like branching corals and sponges) can offer many different types of habitat and as a result can provide food, shelter, and nursery places for many different kinds of organisms.

   Discuss how a benthic community might benefit from structural modifications that increase available surface area. Depending upon the type of modification, these benefits could include increased shelter for different species, increased availability of food for surface grazers, more sites for larvae to atttach, and more places upon which non-motile organisms may attach.

2. Tell student groups that they are to find out what sorts of habitats explorers on the 2003 Charleston Bump Expedition might find. Have students read relevant trip logs from the 2001 Islands in the Stream Expedition, and visit http://www.wwf.org.uk/filelibrary/pdf/darwin_mounds.pdf

for information about a recently discovered group of hard-bottom habitats in the United Kingdom's 200 nm offshore zone. Have students pay particular attention to organisms that modify or enhance habitats by increasing surface area (such as branching corals and sponges). Have students find pictures or illustrations of these organisms. In addition to printed reference books, the Ocean Explorer Gallery (http://oceanexplorer.noaa.gov/, click on "Gallery") and http://biodicac.bio.uottawa.ca have lots of images suitable for downloading.

3. Tell student groups that their assignment is to "engineer" a model benthic habitat site to increase the available surface area and habitat variety, based on living and non-living features typical of the habitats they have researched. Have each group begin with a flat surface of modeling clay, approximately 20 cm x 20 cm. Students will then modify this surface by adding various shapes (dowels, spheres and partial spheres, hollowed out shapes repesenting caves and overhangs, circular depressions in the clay surface representing scours, etc.), keeping track of the total surface area available in their model habitat. Potential features include boulders, caves, overhangs, scours (curved depressions in the clay surface), and cylindrical corals. You may want to add more complex shapes such as sponges with holes in their surface or branched corals depending upon available time and students' ambition.

   Prior to beginning the modeling assignment, you may want to review formulas for calculating the surface area of various geometric shapes:
   Area of a rectangle = L ength • Width
   Area of a circle = π • (radius)^2
   Area of a cylinder = height • π • (radius)^2
   Area of a sphere = 4 • π • (radius)^2

   Each group will begin with roughly the same area (20 cm • 20 cm = 400 cm^2). As they add features to increase surface area, be sure students remember to subtract the surface area that is lost due to the "footprint" of their object. If they add a half sphere to represent a boulder, for example, they have to subtract the area of the circle occupied by the "footprint" of the boulder. Groups should prepare a written summary of their modifications to the initial flat surface, including calculations of the surface area increase produced by each modification. Tell students that their models will be judged according to the following formula:
   Score = (Percent Area Added to the Beginning Surface) • (Number of Different Shapes)

4. Have each group present and discuss their model habitats, explaining what natural features (actually found in deep-water communities) are represented by each shape in the model. Lead a discussion of which organisms and shapes add the most variety to a benthic community. Branched shapes can greatly increase total surface area without occupying very much "footprint" space. Highly folded surfaces can mutliply available surface area by orders of magnitude, and are an important feature of many biological structures (such as lungs, gills, and other surfaces where diffusion takes place). Porous structures such as sponges, gravel, or loose sediment also greatly multiply available surface and provide different-sized shelter spaces as well as increase surface area. Based on this discussion, have students describe the features of the most diverse benthic habitat they can imagine, and compare this hypothetical vision to what scientists actually find during the 2003 Ocean Exploration expedition to the Charleston Bump.

The BRIDGE Connection

www.vims.edu/BRIDGE/ – Click on "Ocean Science" in the navigation menu to the left, then "Biology," then

"Invertebrates," then "Other Inverts," for resources on corals and sponges. Click on "Ecology" then "Deep Sea" for resources on deep sea communities.

The "Me" Connection

Have students write a short essay describing structures in their own bodies that increase available surface area, and why these structures are important.

Connections to Other Subjects

English/Language Arts, Physical Science

Evaluation

Models and written reports prepared in Step 3 provide opportunities for assessment.

Extensions

Log on to http://oceanexplorer.noaa.gov to keep up to date with the latest Charleston Bump Expedition discoveries, and to find out what researchers are learning about deep-water hard-bottom communities.

Resources

http://oceanica.cofc.edu/activities.htm – Project Oceanica website, with a variety of resources on ocean exploration topics

http://pubs.usgs.gov/of/of01-154/index.htm – U. S. Geological Survey Open-File Report 01-154 "Sea-Floor Photography from the Continental Margin Program"

http://oceanexplorer.noaa.gov/explorations/islands01/log/sab_summary/sab_summary.html – Summary report of the 2001 Islands in the Stream Expedition

http://www.wwf.org.uk/filelibrary/pdf/darwin_mounds.pdf – Report on the Darwin Mounds, a recently discovered group of hard-bottom habitats in the United Kingdom's 200 nm offshore zone

National Science Education Standards

Content Standard A: Science As Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard C: Life Science
- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard D: Earth and Space Science
- Structure of the Earth system

Content Standard F: Science in Personal and Social Perspectives
- Populations, resources, and environments

For More Information

Paula Keener-Chavis, National Education Coordinator/Marine Biologist
NOAA Office of Exploration
2234 South Hobson Avenue
Charleston, SC 29405-2413
843.740.1338
843.740.1329 (fax)
paula.keener-chavis@noaa.gov

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